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A Frequency-comb Based System for Time Domain Spectroscopy in the Near Infrared

Description

This invention is a technique to acquire highly-precise, infra-red measurements of absorption spectra in gases using a laser-based spectroscopic apparatus equipped with devices called optical frequency combs (stabilized pulsed lasers that produce a comb of well-defined frequency of light). The apparatus employs two optical combs; one comb placed in the path of the measurement signal and the other comb placed outside the path of the measurement signal. The two optical combs are phase-locked in a manner that their repetition rates differ by a small frequency. Specific conditions are required to generate a rapid, high-resolution, time-domain signature of the signal. This optical comb combination results in a time-domain signal that provides more information for a gas measurement signal with enhanced signal-to-noise ratio while reducing systematic effects that normally arise from variations in system spectral response.

Applications

- **This frequency comb measurement technology has potential applications in many advanced fields of science that require the identification or manipulation of atoms or molecules such as:**
  • Trace gas detection and sample analysis in a wide variety of areas including climate monitoring, combustion research and chemical analysis
- • Detection of toxic biochemical agents in airport staging areas of trace amounts of molecules found in explosives or biologically hazardous materials
- • Studies of ultrafast dynamics and quantum computing
- • With refinements, the technology might be applied in many other research fields and technologies, from medical tests in doctor's offices, to synchronization of advanced telecommunications systems, to remote detection and range measurements for manufacturing or defense applications

Advantages

- • A large spectral bandwidth allowing for the observation of global energy level structure of many different atomic and molecular species
- • High spectral resolution for the identification and quantitative analysis of individual spectral features
- • High sensitivity for detection of trace amounts of atoms or molecules and for recovery of weak spectral features
- • A fast spectral acquisition time which takes advantage of high sensitivity for the observation of spectral changes due to changing environmental conditions

Abstract

A method of comb-based spectroscopy with synchronous sampling for real-time averaging includes measuring the full complex response of a sample in a configuration analogous to a dispersive Fourier transform spectrometer, infrared time domain spectrometer, or a multiheterodyne laser spectrometer. An alternate configuration of a comb-based spectrometer for rapid, high resolution, high accuracy measurements of an arbitrary cw waveform.

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Citations

1. I. Coddington, W. C. Swann, N. R. Newbury, Measuring optical waveforms with fiber frequency combs, IEE LEOS Sumer Topical Meeting, Optical Frequency & Time Measurement and Generation, Winter Topical, Innsbruck, Austria, 01/11/2009 to 01/14/2009.

N. R. Newbury, I. Coddington, and W. C. Swann, Infrared Time Domain Spectroscopy with Synchronized Frequency Combs, in Laser Applications to Chemical, Security and Environmental Analysis, OSA Technical Digest Series (CD) (Optical Society of America, 2010), paper LTuA3.

Related Items

- Article: Optical Frequency Combs

References

- U.S. Patent Application #20110069309
- Docket: 09-024

Status of Availability

This invention is available for licensing.

Last Modified: 01/03/2011